Rugby union movement patterns: The impact of fatigue and substitute players

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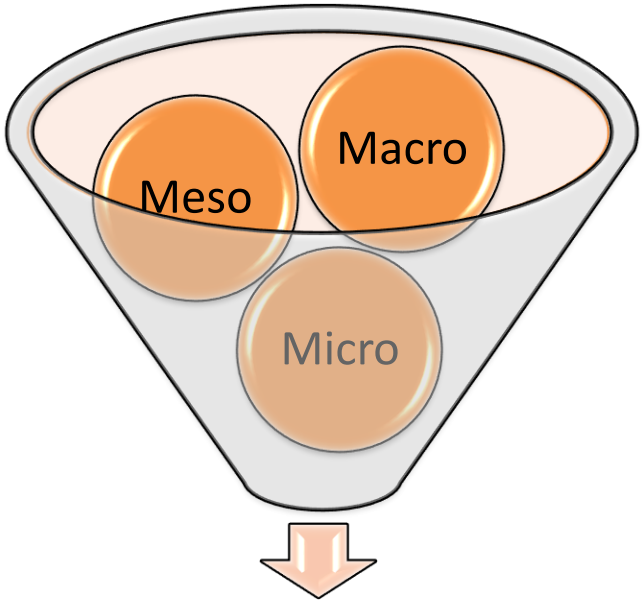
Fatigue in team sports

Fatigue = ↓ in total and high-intensity running distance

(Waldron and Highton, 2014, Sports Med 44:12)

Distribution of energy resources



Pacing schema

Macro-pacing (pre-match)

- hydration, fuel availability, motivation, temperature, opposition, whole-game/substitute

Meso-pacing (half time)

- homeostatic disturbance, opposition, scoreline

Micro-pacing (continuous)

- homeostatic disturbance, opposition, scoreline

Edwards and Noakes, 2009, Sports Med 39:1

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Professional Rugby Union

Rugby union is characterised by **short-duration, high-intensity efforts** during which **players collide,** often while **running at full speed**; interspersed by longer **low-intensity periods of standing, walking and jogging**.

(Austin *et al*., 2011, J Sci Med Sport 14:3)

Diversity of Physical Requirements

The **game demands differ for** players in **different positions.**

(Deutsch *et al*., 2007, J Sport Sci 25:4)

Research Aim

Understand the nature of fatigue in professional rugby union

- What is the influence of match period and position on movement patterns?
- What is the influence of substitutes on movement patterns?

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Methods – Global Positioning System (GPS)

Variables measured

- Playing time
- Relative distance ($m.min^{-1}$) in speed zones

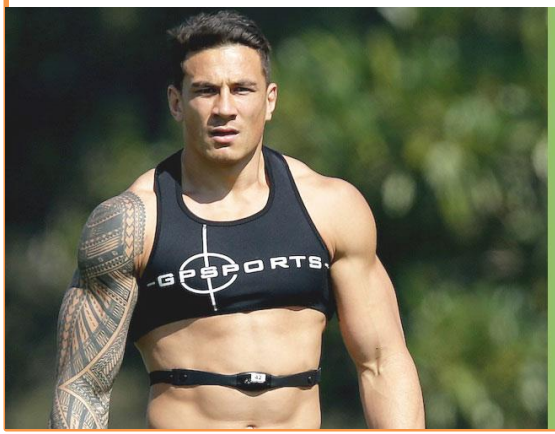
Speed bands		
Walking	0-2$m.s^{-1}$	Low intensity running 0-4$m.s^{-1}$
Jogging	2-4$m.s^{-1}$	
Striding	4-6$m.s^{-1}$	High intensity running >4$m.s^{-1}$
Sprinting	>6$m.s^{-1}$	

- Sprint (>6$m.s^{-1}$) frequency
- Acceleration (>2.75$m.s^{-2}$) frequency
- Accelerometer

  Total impacts >5$G.min^{-1}$

  High-intensity impacts >8$G.min^{-1}$

SPI Pro GPS unit
(GPSports, Canberra)
mass = 76g;
size = 87 x 48 x 20 mm
5Hz GPS Tracking
100Hz Tri-axial Accelerometer



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Methods

Player characteristics
Age 25.5 ± 2.4 years
Body mass 101.5 ± 12.2 kg
Stature 1.86 ± 0.07m

- Whole game players – start game and complete >35 min in 2nd half
- Substitute players – 2nd half replacements

Statistics

- Factorial ANOVA
- Paired and independent sample t-tests
- Cohen's effect size

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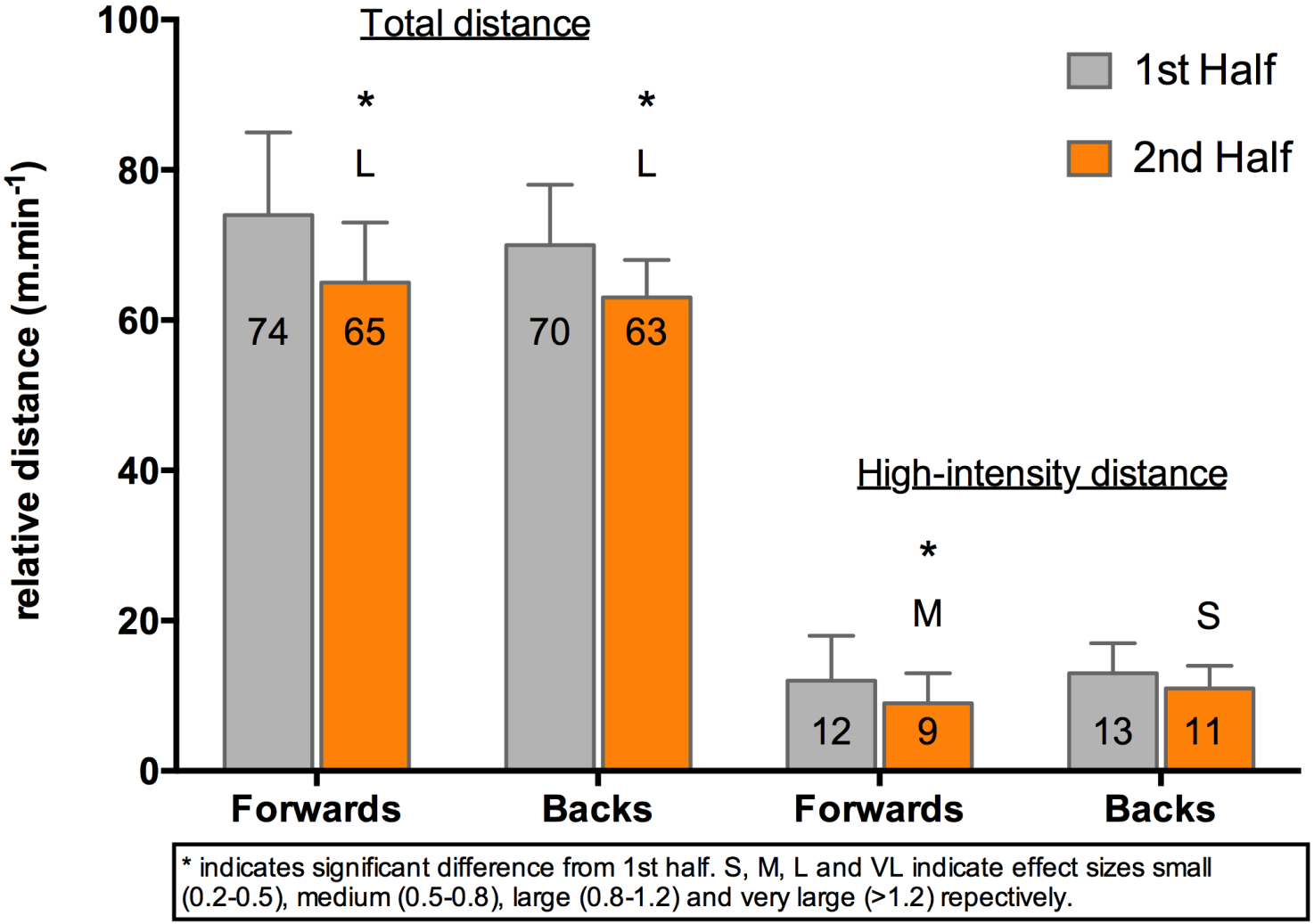
Results – Effect of half on total and high-intensity distance



* indicates significant difference from 1st half. S, M, L and VL indicate effect sizes small (0.2-0.5), medium (0.5-0.8), large (0.8-1.2) and very large (>1.2) repectively.

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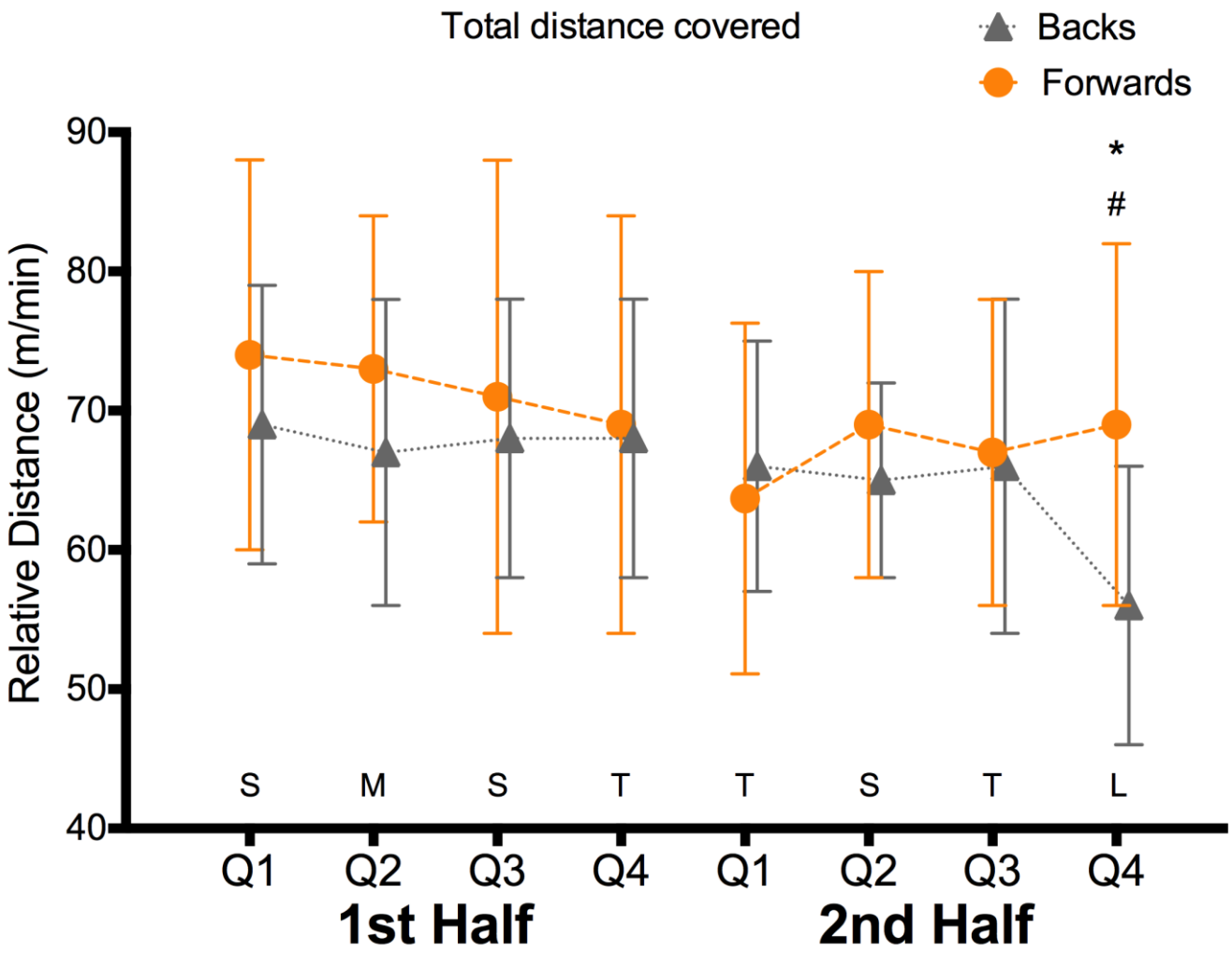
Results – Total distance per match period



* indicates significant difference between backs and forwards, # indicated significant different from all othe match periods. T, S, M, L and VL indicate effect sizes trivial (<0.2), small (0.2-0.5), medium (0.5-0.8), large (0.8-1.2) and very large (>1.2) repectively.

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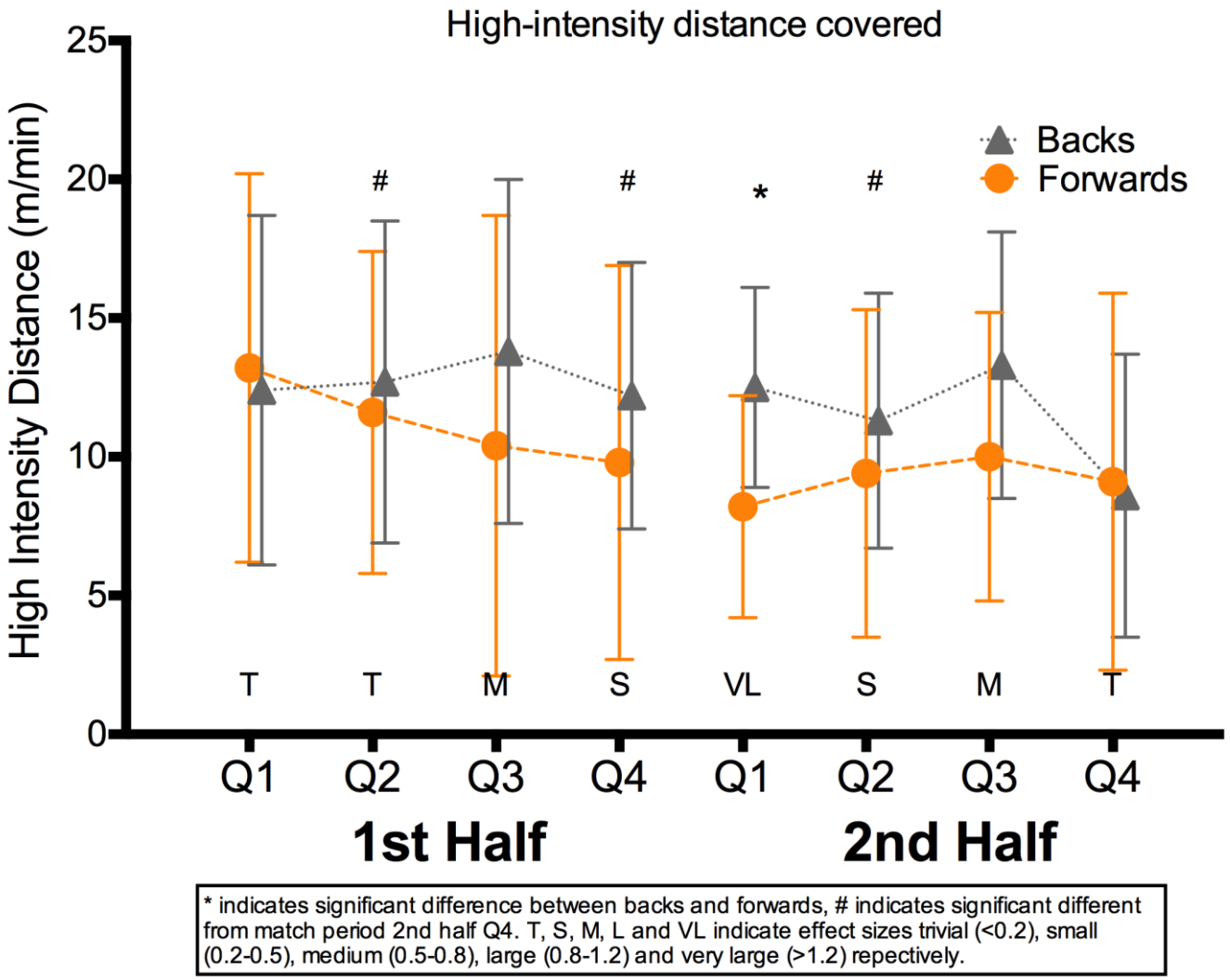
Results – High-intensity distance per match period



* indicates significant difference between backs and forwards, # indicates significant different from match period 2nd half Q4. T, S, M, L and VL indicate effect sizes trivial (<0.2), small (0.2-0.5), medium (0.5-0.8), large (0.8-1.2) and very large (>1.2) repectively.

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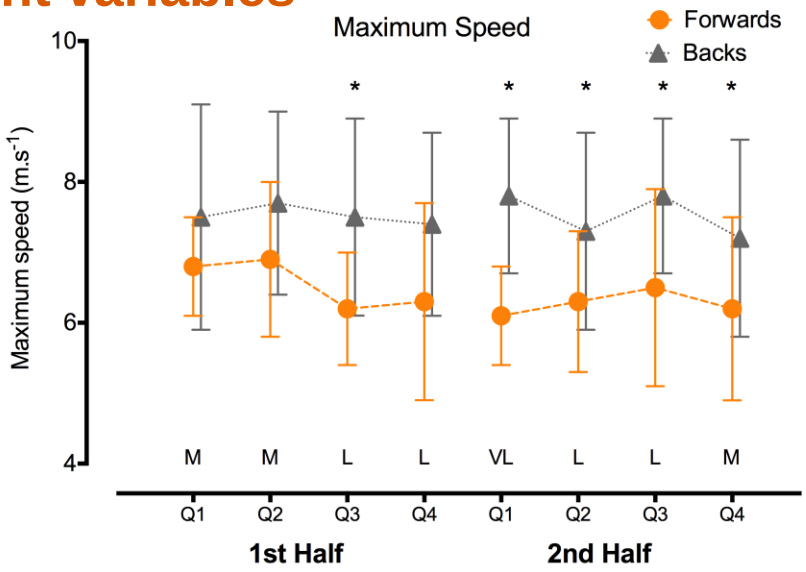
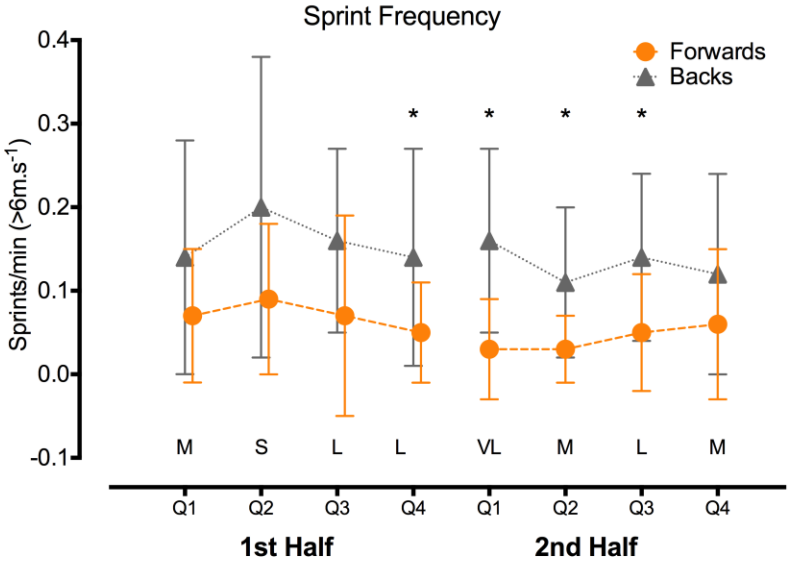
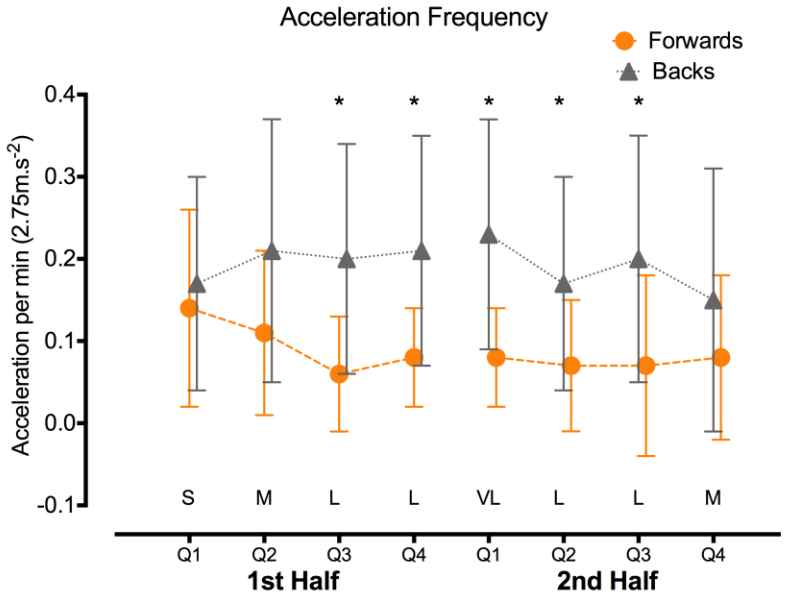
Results – Match period effects sprint variables

Sprint and acceleration frequency are reduced in the 2nd half for forwards, but not for backs.







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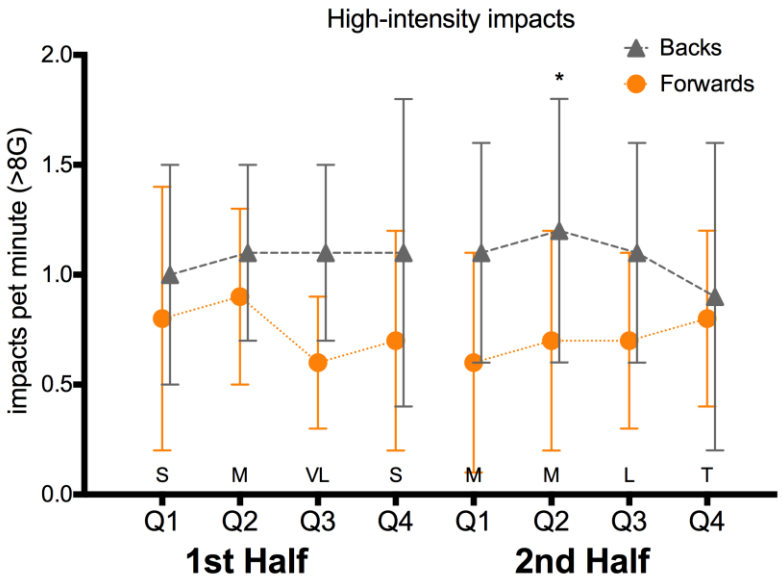
The effect of physical contact

↑↓ physical contact = ↓ total and high-intensity running distance (Johnston et al., 2014, Int J Sports Physiol Perform, Epub)

Forwards experience ↑ contact involvements than backs
(Deutsch *et al*., 2007, J Sport Sci 25:4)

Accelerometer data – backs experience ↑ total (>5G) and high-intensity (>8G) “impacts” than forwards

Data doesn’t fit fatigue model



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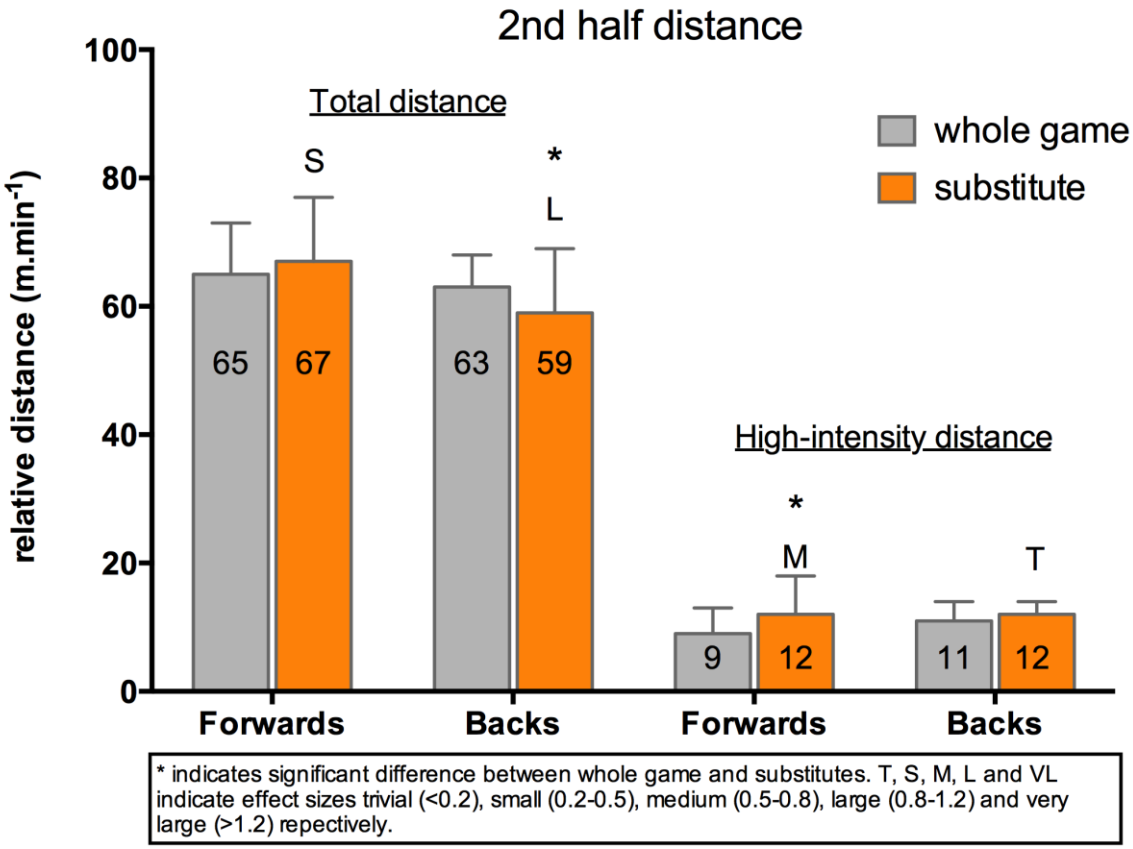
Results – Effect of substitutes



Forward substitutes ↑ sprint and acceleration frequency and high-intensity impacts

Back substitutes = sprint and acceleration frequency, but n = 3

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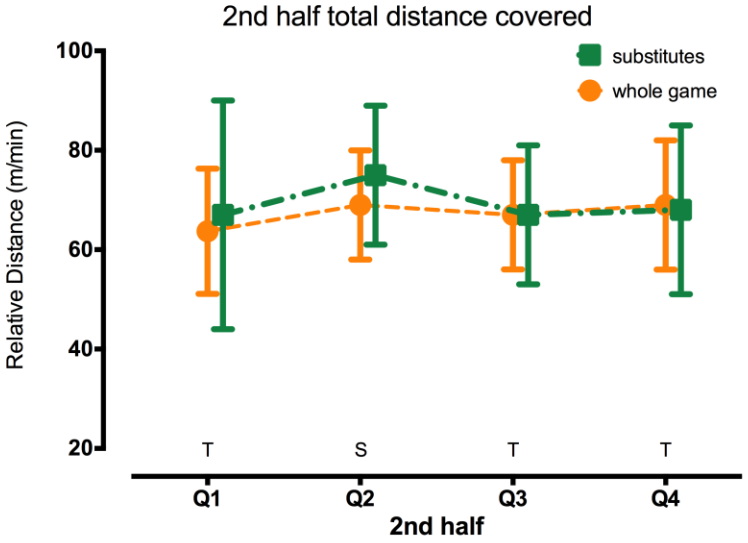
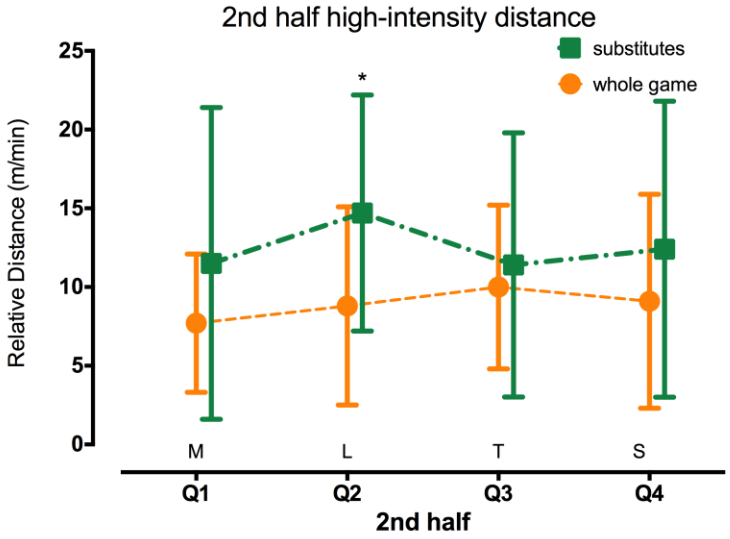
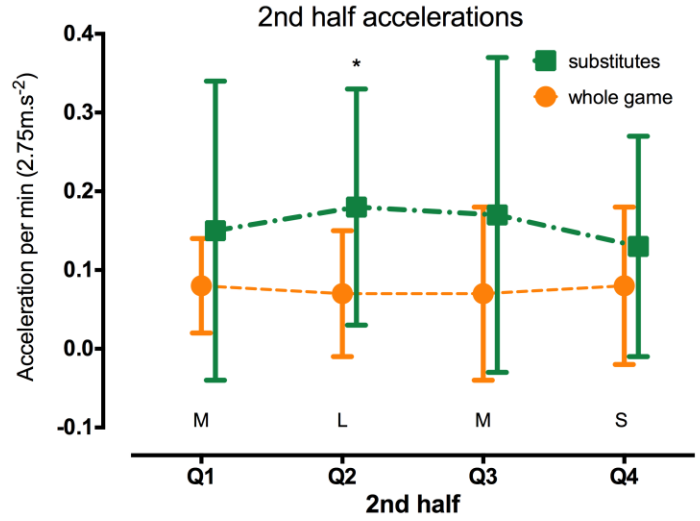
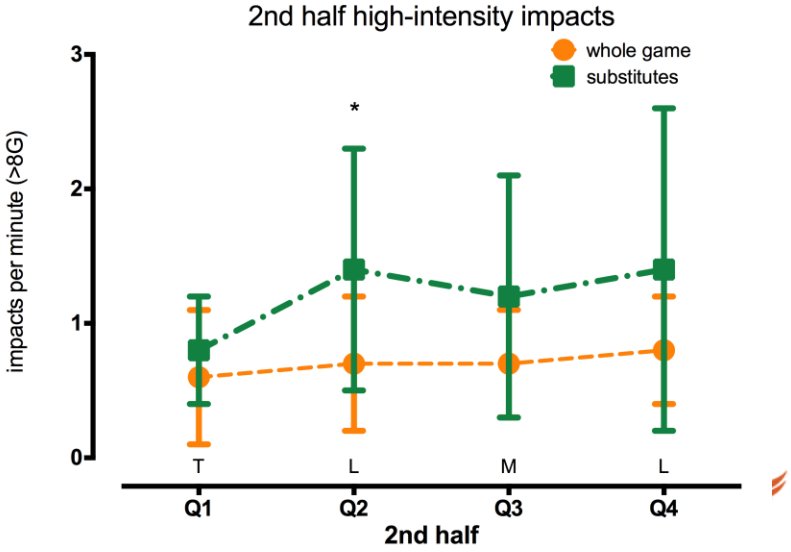
Results – effect of forward substitutes









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Conclusions – running distance

Rugby union players ↓ total (10%) and high-intensity (18%) running in 2nd half.

Similar results in soccer[1], rugby league[2] and rugby sevens[3].

BUT

Rugby union work rates are much lower than other sports (~70 vs. ~100m.min^{-1})[1,2,3]

1. Bradley and Noakes, 2013, J Sport Sci 31:15
2. Waldron et al., 2013, Int J Sports Physiol Perform 8:2
3. Higham et al., 2011, J Sci Med Sport 15

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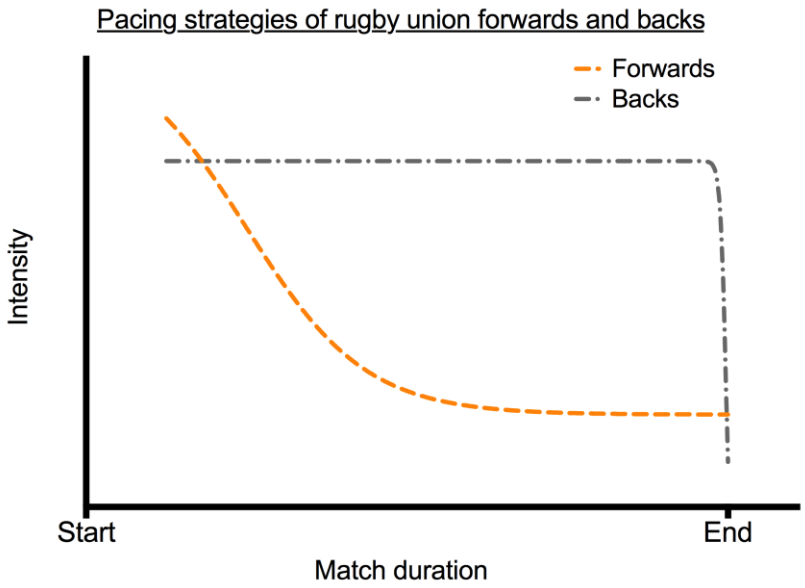
Conclusions – fatigue profile



Backs and forwards demonstrate differing fatigue profiles.

Pacing profile	
Forwards	**Backs**
"Slow positive"	"Flat"

Forwards progressively ↓ total and high-intensity distance, maximum speed, sprint and acceleration frequency

Backs maintain total and high-intensity distance, maximum speed, sprint and acceleration frequency for majority of match

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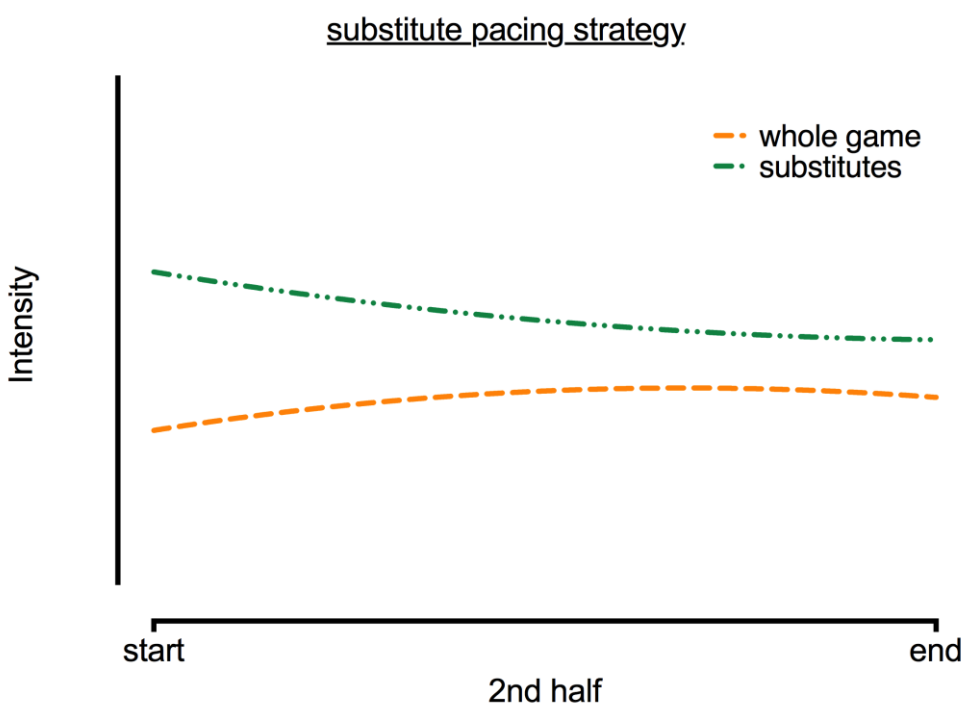
Conclusions – Impact of substitutes



Substitutes ⬆ match intensity by ⬆ high-intensity distance, acceleration frequency and high-intensity impacts.

Substitutes set a higher pacing strategy in the early part of their exercise bout

– a **“one bout, all out”** strategy

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For the coach - Take home message

- Fatigue is evidenced by reductions in total and high intensity running distance and sprint and acceleration frequencies.
- Fatigue profile of forwards and backs is different
- Monitor high-intensity running distance to determine onset of fatigue
- Replacing fatigued players with substitutes is an effective method of maintaining playing intensity

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Goodbye and thank you for listening!

Acknowledgements

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